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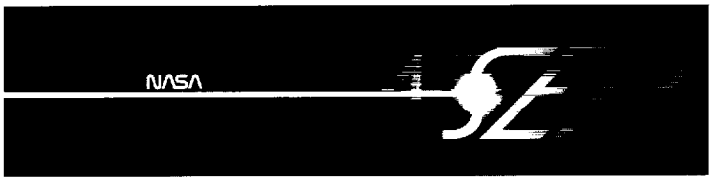


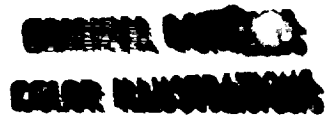
Learning About Science, Engineering, and Research

NASA reaches out to help rebuild America's science and technology workforce

[redacted]

Introduction

The American people expect and deserve leadership in the international community now and as we move into the 21st century. This nation pioneered the world's standards of living and many of the technologies which have allowed the human race to burst the limits of imagination and capability in the decades since World War II.



But the "educational pipeline" which produced scientists and engineers of the 1950's through the '70's is drying up. Fewer students are entering science and engineering careers because they decide science and math are too hard, dull, or "nerdy." The shocking statistic is that this decision is not made when they enter college, but in third or fourth grade—long before they are aware of the excitement the future can hold. Recent international math achievement tests rank U.S. students on a par with Thailand and Hungary—and far behind other nations (Hong Kong and Japan ranked 1 and 2). U.S. rankings in physics, chemistry and biology ranged from abysmal to mediocre compared with other nations.

Goal 1

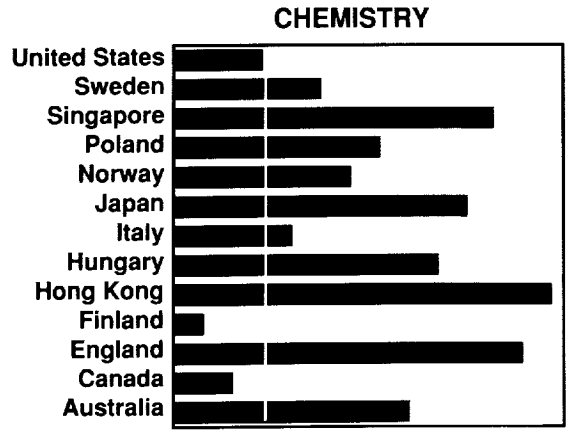
All children, from all backgrounds, must have a quality education which includes science and mathematics, and an equal opportunity to become a vital part of our science and engineering workforce—as workers, beneficiaries, taxpayers, and voters.

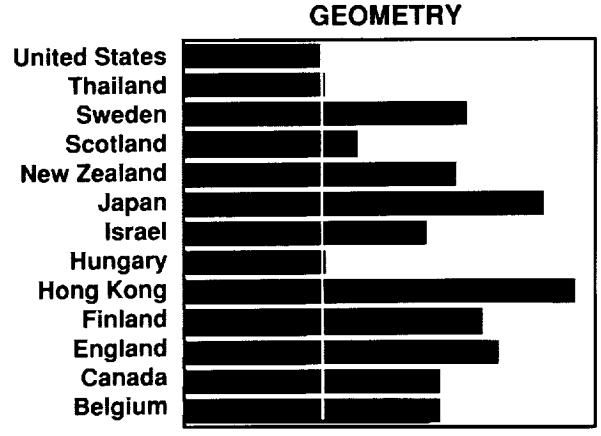
This decline has alarmed Congress which, in 1987, established a Task Force on Women, Minorities, and the Handicapped in Science and Technology (P.L. 99-383) to define the problem and find solutions. If left unchanged, the Task Force has warned, "the prospects for maintaining an advanced industrial society will diminish." [1]

NASA is supportive of the six goals outlined by the Task Force—and which are paraphrased on these pages—and is carefully assessing its education programs to identify those

HOW AMERICA SCORED

Graphs below are typical of how students from 13 countries, including America, fared on International Science and Math Achievement Tests. (Source: International Association for Evaluation of Educational Achievement)





offering the greatest potential for achieving the Task Force objectives with a reasonable range of resources. A major initiative is under way on behalf of NASA at its Marshall Space Flight Center in Huntsville, Alabama, where highly effective features of several NASA education programs along with innovations are being integrated into a comprehensive pilot program. This program, dubbed Project LASER, is discussed presently.

"It is obvious that if this trend is not corrected, the Buck Rogers of the 1990s will be living in Seoul, not Chattanooga, Los Angeles, or Chicago.

University of Tennessee President Lamar Alexander[5]

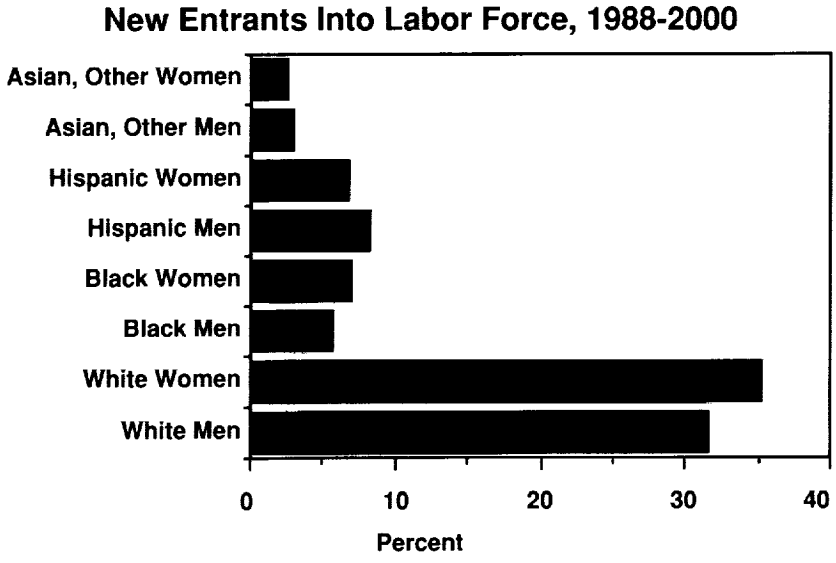
Finding new minds

What made America great was not manifest destiny, but the hunger of immigrants who were willing to sacrifice, to perform harder and learn more. When Leo Durocher said that "Nice guys finish last," he meant that the hungry ones hustle to finish first. Today that hunger and hustle are found throughout the world in nations that are outperforming America in the marketplace, and which have recognized, as Japan did almost three decades ago, that "Economic competition is technical competition, and technical competition has become educational competition."

Goal 2

Education must be reformed to allow American students—from pre-kindergarten to grade 12—to enter college as future competitors in the international marketplace.

It can also be found and nurtured in America's inner cities and impoverished citizens if we provide the opportunities to learn and grow. In the year 2000, 85 percent of the new workers will be members of minority groups, women, and the disabled. Further, the nation will be short some 560,000 science and engineering professionals at that time. As expressed by the Task Force, "The Nation can meet future potential shortfalls of scientists and engineers only by reaching out and bringing



THE CHANGING WORKFORCE
Changing demographics will markedly affect the composition of the future workforce. Of the new workers entering the labor force between 1988 and the year 2000, less than a third will be the white males traditionally sought by most employers. (Source: U.S. Bureau of Labor Statistics)

members of these underrepresented groups into science and engineering. America's standing and competitiveness depend on it."

For years it has been easier to deal with the students who were readily available in the schools near the factory and around the executives' neighborhoods. But assuring America's vitality and competitiveness requires that business and government reach outside their "comfort zones" to capture the imaginations of minority and disadvantaged students. Simply stated, it is folly to ignore large segments of any manpower pool.

Goal 3

By the year 2000 the number and diversity of American science and engineering graduates must expand to meet the demands for faculty, industry, and government.

If left untrained, the poor and disadvantaged children of today will become the poor and disadvantaged parents of tomorrow and the pattern will repeat. They will also become a terrible burden on the economy and keep the nation from reaching its full potential. If tapped, they can become the greatest resource for building the economy and regaining stature and economic power in the world marketplace. In the words of the Task Force:

BASIC SPACE TECH
Students from Bob Jones High School receive a lecture on basic rocket propulsion as part of the Space Science and Technology pilot course. (NASA photo)

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AFTER SCHOOL
Students who stay at the public library to study or just read after regular school hours will be offered introductions to science through space. (NASA photo)

"We should commit to the task of producing a world-class science and engineering workforce not only because science and technology happen to be the coin of international power. We should take action not just because Japanese students score higher in international tests. We should take action not only because the opportunity costs of not acting—school dropouts, welfare, and prisons, for example—are staggering.

"One, every American citizen, regardless of background, gender, physical disability or race, should receive the educational and economic opportunity to develop to his or her fullest potential.

"Two, we should extend rights not only in the name of social justice, but as a test of a modern, well-functioning society. This is the standard by which we should continue to stand and be measured."

Goal 4

Because Federal R&D resources strongly influence national science and engineering work, they must be used to help leverage the world's best science and engineering workforce by the year 2000.

From the stars to the Earth

NASA can and will play a vital role in this effort. Because the Space Act directs NASA to expand human knowledge of space and to disseminate information to the widest audience, NASA is a type of education agency, well-suited to capture a child's imagination. Edward Mabley, president of the Society of Automotive Engineers, observed, "Have you ever seen a kid who

didn't like a car or airplane?"[2] Or a spaceship? Nothing fires the imagination as space does. But for many students, that becomes limited in elementary school.

NASA does not entertain the notion that all students it contacts will want to become astronauts or space scientists. Most will move on to other career interests, many of them outside of science and engineering. However, NASA does know that unless the nation provides itself a large enough pool of scientists and engineers, and taxpayers who appreciate their importance, then the agency will find itself in an intense competition for the few skilled people who are available. Through their natural interest in space, students can be stimulated to develop skills in science and mathematics that will serve all disciplines. And the best environment for expanding man's presence in space is a nation with a vibrant economy driven by first-rate technical capabilities in all fields, and supported by a citizenry which is functionally literate in science and mathematics.

"Education is a way of life. And educational reform is an urgent responsibility for every parent, every student, every community. And those who do not advance the cause of education hinder it."

President George Bush[10]

Goal 5

The Federal government will continue to set the pace in providing accessible, equitable, and favorable workplaces for under-represented groups in science and engineering.

Although all levels of education must be addressed, studies have identified the first four years of primary school education as the most crucial. Young people are naturally curious and eager to learn. However, as they reach the third to fourth grade, there is a general tendency for their interest in the more difficult concepts of mathematics and science to give way to less difficult and entertaining activities. This is markedly true for minorities, girls, and children from socially and economically deprived situations. This problem is caused by a lack of "hands-on" experiences that cultivate and stimulate a child's natural curiosity, and in rote learning that appears to have no immediate application or reward.

As noted by Philip and Phylis Morrison—a noted MIT physics professor and a specialist in elementary science education—one of the problems with today's metropolitan society is that many children are not exposed to the same learning experiences as 100 years ago.[3] Children who grew up in small towns and on the farm "knew intimately many things that are not in the experience of children coming to school today ... the rhythm of the moon in the sky. They knew many of the serious steps to keep alive animals for whom they had responsibility and on whom they depended.... They knew a good bit about machinery and how it worked, how it could be mended, what you could do with it that was not exactly what it was intended

"Fortunately, producing an adequate supply of scientists and giving scientific literacy to the non-scientists can be accomplished by the same means—teaching excellent science to every child at the elementary school level."

Educator Daniel Koshland[7]

for." Today, few children build their own radios—a Walkman is cheaper than a kit—or comprehend its workings beyond the face of the volume control.

A LASER to light the way

Project LASER, a major initiative being undertaken by Marshall Space Flight Center on behalf of NASA, will provide hands-on experiences that challenge children to continue science and math studies.[4] "Laser" was selected because it is a readily recognized high-tech device. (Significantly, most people cannot tell what the acronym means or how a laser works.) As adopted by the Marshall Center's education outreach program, LASER means Learning About Science, Engineering, and Research. The brightly-colored logo depicts a laser etching its own name.

There are several areas of focussed effort designed into Project LASER. Although the project includes all teachers and students in elementary through high schools, there will be an intense focus of effort, technology, and reinforcement designed to draw underprivileged and underrepresented children into the mainstream of the educational process and to keep them there.

"Elementary teachers are often regarded as the best science teachers because they are quick to admit to not knowing."

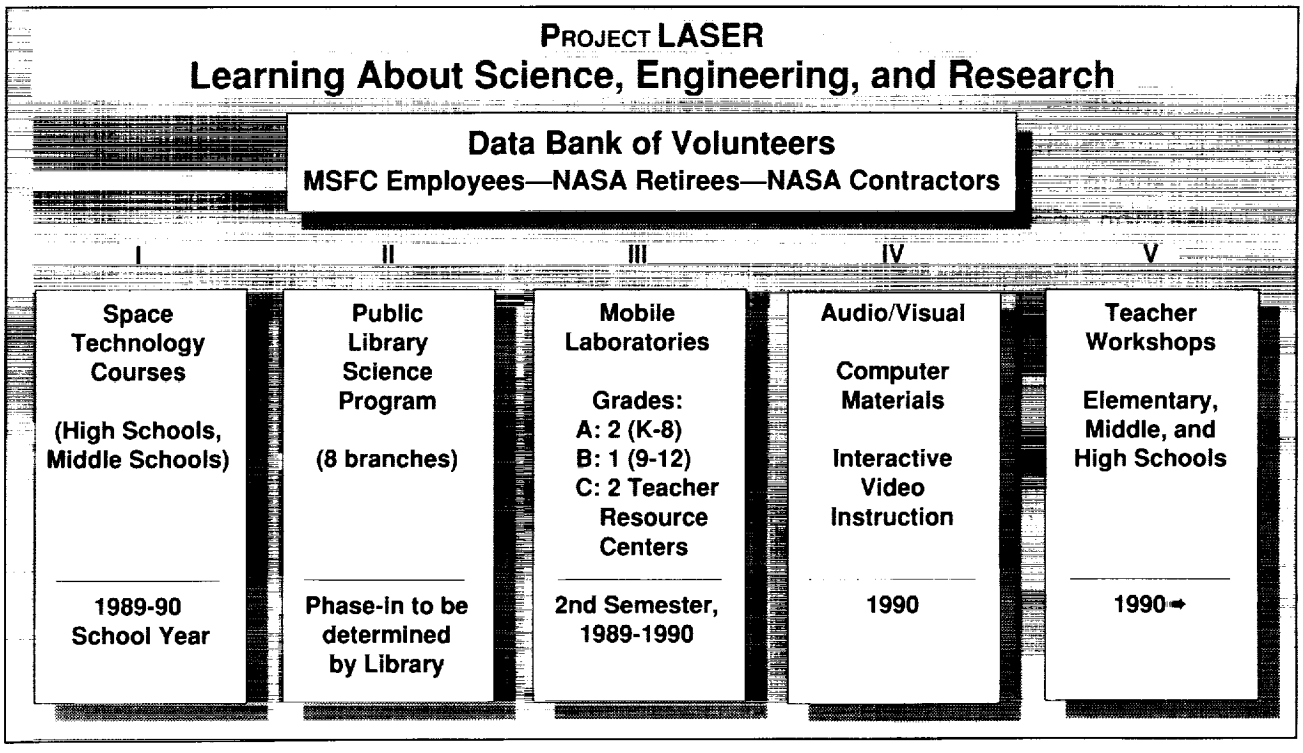
Educator Robert Yager[6]

Goal 6

American culture must change.
News and entertainment media, businesses and communities are needed to reverse negative images:

- **"Mad" scientists portrayed in entertainment media.**
- **Science and math are "too tough" or "for nerds."**
- **"Only geniuses need apply."**

PROJECT LASER ELEMENTS
Major elements of Project LASER, and their development schedules, are depected below. The Space Science and Technology Course is outlined at right. (NASA diagrams)



SCIENCE DAY
A Marshall Center volunteer supporting Project LASER introduces elementary students to physics experiments. Such an outreach will be possible for more schools through Mobile Discovery Labs. (NASA photos)

In addition, NASA believes special attention is required in three areas:

First, assisting teachers in ways which facilitate and enrich science and mathematics education without adding to the teaching burden.

"Einstein didn't learn about atoms from lectures."

Education ad, ca. 1988 [8]

Second, developing practical applications and interesting "hands-on" activities that attract children to put forth the effort necessary for understanding mathematics and science.

Third, expending a greater effort in grades 3 through 8 to create and maintain the necessary interest through positive reinforcement to sustain the students' desire to learn algebra, geometry, calculus, biology, chemistry, and physics.

Space Science and Technology Course

I. Introduction and overview: Why explore space?

II. Astronomy: Heavenly bodies in space as an environment.

III. History: Man's venture to the sky and beyond.

IV. Getting there: Technology required to go from idea to spaceflight.

V. Space flight: Man's accomplishments and plans.

VI. Experiments in space: What we test and observe.

"We are unique in our ability to capture the interest of children and young adults. No program of any other agency, public or private, can inspire kids more than our activities on the cutting edge of space or aeronautics research."

NASA Administrator Richard Truly[11]

Within Project LASER are five major elements; others may be added as our understanding of educational needs and capabilities is refined. The Marshall Center is using the Huntsville and Madison County School Systems and its own facilities as the laboratory in which LASER programs are developed. As the elements mature they will be "spun off" to other NASA centers, Federal agencies, school systems, and businesses—anyone, in short, who has the need and the interest.

"The essence of science is curiosity. We must instill in our children the curiosity about their everyday world that will always lead to discovery."

Michael S. Brown, 1985 Nobel laureate in physiology and medicine [9]

The major program elements within LASER are:

Volunteer Databank: Current and retired employees of Marshall Center have been asked to volunteer to support space activities at various city and county schools. "Job categories" include tutors for students and small groups; instructors at schools or field trips; consultants for teachers; science fair judges; and volunteers providing other assistance as needed. An important element will be a Discovery Lab at the Marshall Center which will provide specific laboratory capabilities for the schools.

Space Technology Course: This course is being developed by a team of certified teachers and Marshall Center scientists and engineers. Implementation is under way at Bob Jones High School in Madison County and will continue as a full-time course of instruction throughout the 1989-90 school year. Students who attend must arrive an hour before regular classes, but will receive one elective credit. Development of a space technology textbook is being considered as an extension of this program. Marshall Center earlier "adopted" Johnson High School and is helping it develop space science studies integrated with traditional courses.

"At a time when the need for strong math and science programs in our schools has never been greater, we recognize that government agencies and industry can and must make important contributions to education."

MSFC Director Jack Lee

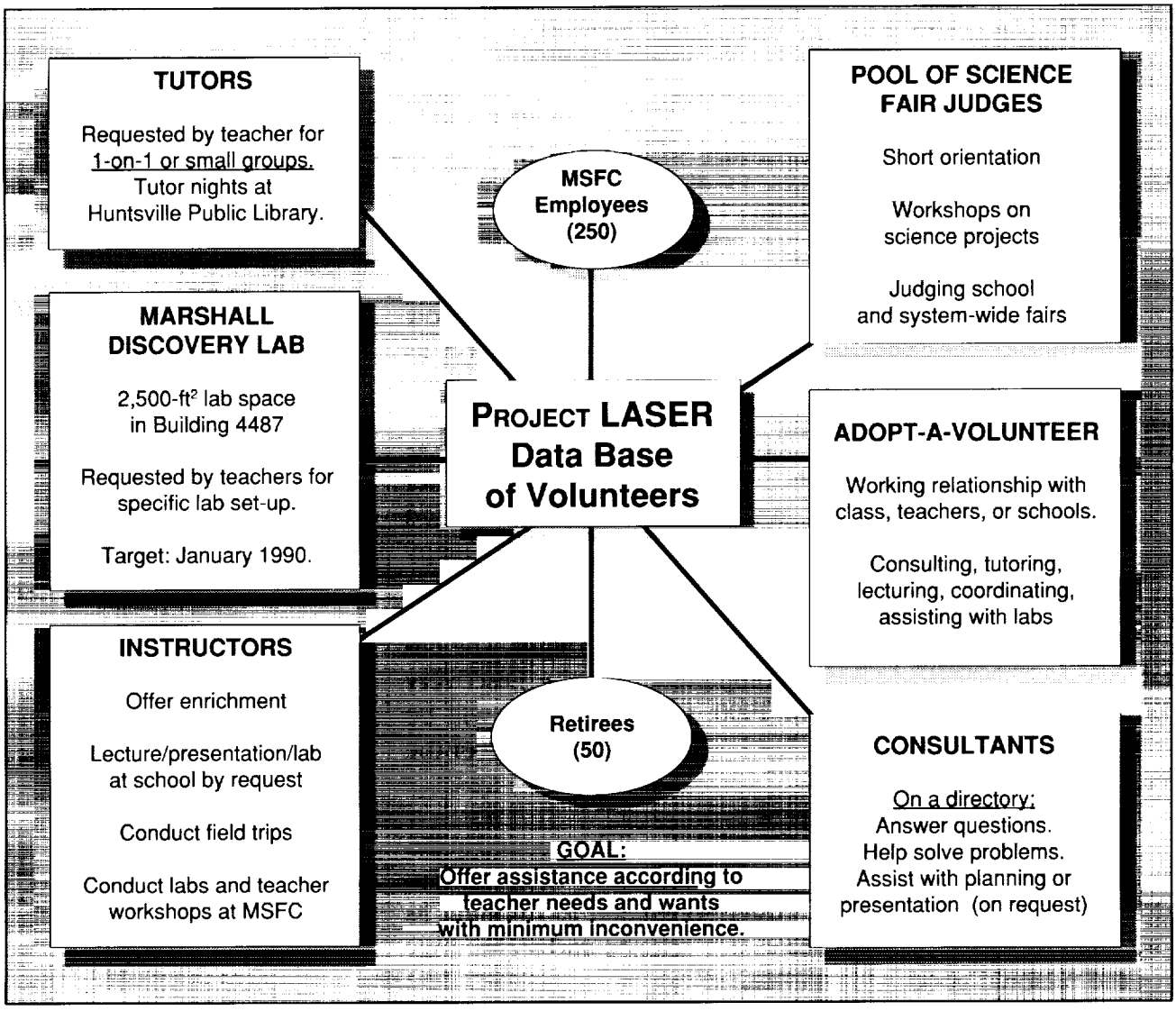
Public Library Science Program: The Huntsville Public Library's main branch has discovered that many children from nearby housing projects "hang out" at the library until their parents return home from work. This provides a natural environment in which science and math programs can be presented as an adjunct to classroom learning. The library may also host weekend, evening, and summer programs to help teach children. The library management has agreed to furnish space in the facility for the Marshall Center to engage the children in learning with NASA-provided materials.

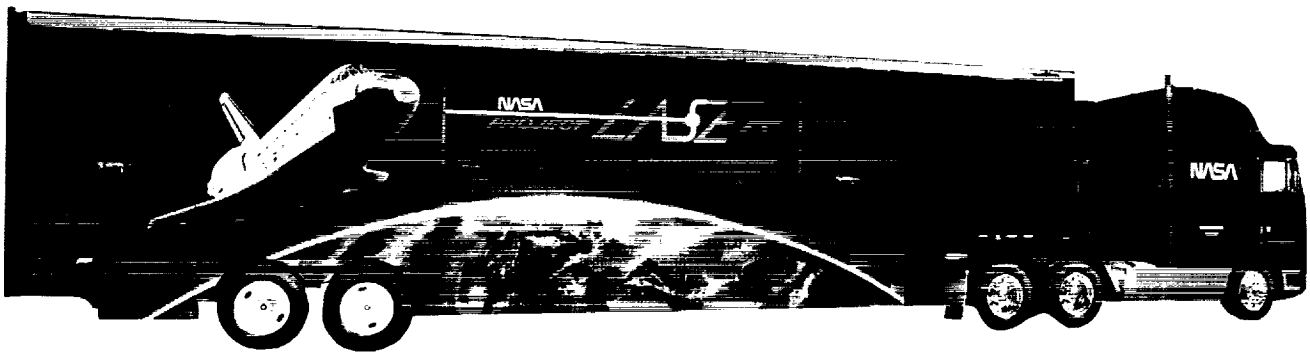
Mobile Discovery Laboratories: This is derived from the Spacemobile familiar to many Americans. The Mobile Labs will carry simple lab equipment and computers to provide

hands-on activities and demonstrations for students, and provide teachers with classroom activities. There will be two for grades K-5, and one for 6-8. At work stations in the mobile labs, teams of two to five students will use prepackaged materials that will show them practical applications of principles being taught in the classroom.

Mobile Teacher Resource Centers: The greatest potential in terms of resources invested in LASER may be offered by the development of Mobile Teacher Resource Centers. Mobile facilities, built on the highly successful NASA-wide system of Teacher Resource Centers (at NASA centers and regional locations), can reach teachers all over the nation, especially those that would otherwise not have the opportunity to avail themselves of this valuable resource. Initially, the vans would visit the six-state region served by the Marshall Center to prove the concept. This would be followed by expansion

LASER WORKERS
LASER's various activities will be staffed by volunteers who have a variety of options for helping the program. (NASA diagram)





to each of the other NASA centers with at least two mobile units per center. The first center is to debut in early 1990.

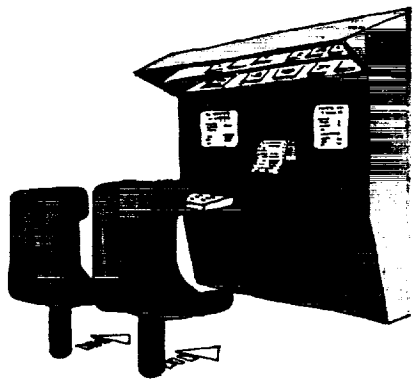
Computer and A/V Materials: The potential of computer-aided learning cannot be underestimated, nor should it be oversold. Not all school systems can afford machines that provide "hypermedia" and other advanced systems. Nevertheless, the potential is great and must be explored to develop affordable systems. The proliferation of VCR's make videotapes a natural medium for presenting educational material, but not simply by taping old movies; new production values and techniques must be used to provide presentations that children want to see and hear. An initiative is under way to join the Alabama University System's audio-video network which is now delivering live interactive instruction by highly-skilled educators in high school classrooms in such subjects as anatomy. NASA would use its new Space Technology Course as a pilot effort to expand its outreach into as many school systems as possible.

Teacher Workshops: "Hands-on" activities are equally important for teachers at all levels. NASA and the Marshall Center will incorporate summer workshops and other related activities into LASER to share the program with as many teachers as possible.

LASER's programs will not be produced overnight. The database, for example, is being completed, and the Discovery Laboratory is to be opened in 1990. Other activities will be initiated during the 1989-90 school year, then refined over the years as experience is gained.

Assistance from industry and academia will be needed in developing these programs. Although NASA has a multi-billion-dollar budget, its monies are largely obligated to fulfilling its primary charter: expanding aerospace science and technology for the national good.

FOR TEACHERS
The Mobile Teachers' Resource Center (above) will be highly visible on the nation's highways as it carries a set of six work stations (below) plus other facilities to teachers at their schools. (NASA photos)



And despite the marvels which NASA has developed, it is not a "know-it-all agency." Neither is it a factory. NASA is an R&D agency. The help of the education community will be needed as NASA brings its expertise and facilities to bear. Most important, the support of the business community will be needed to develop and distribute new educational tools, either by corporate sponsorships, cost-sharing, donations, or other means. Non-profit professional institutions (many of whom have struggled with the education problem for years) are needed to act as receiving agents to make sure that industry receives proper tax credits and to help maintain a proper separation between business and government. Already, several aerospace firms have expressed interest in helping NASA. Education programs and materials which support the overall goals of Project LASER will also be distributed through the Mobile Teacher Resource Centers and Discovery Laboratories.

The support of the entire business community will be needed in what will become the most important investment that any company can make. The return will not come quickly or easily. But the price of not investing is too high to bear.

To my mind, the main task is how generally to improve the education of the young. [You] can do no greater work than help make better the elementary school system throughout the world.

Albert Einstein
(to the League of Nations Committee on International Cooperation, ca. 1924)

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